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AN INVESTIGATION OF FIELD ARTILLERY TECHNIQUES AND FIRE SUPPORT DECISIONS

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In this thesis field artillery operations and fire support decisions are examined. The history of the development of artillery fire support systems is reviewed in order to provide insight into artillery missions. Standard tactical missions are identified and analyzed as well as fire planning and fire support coordination. A specific scenario is analyzed in detail with respect to the fire support decision process. This work attempts

to provide the background information necessary for the construction of more realistic artillery models for use in a modern combined arms combat simulation.

An Investigation of Field Artillery Techniques and Fire Support Decisions

by

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Submitted in partial fulfillment of the requirements for the degree of

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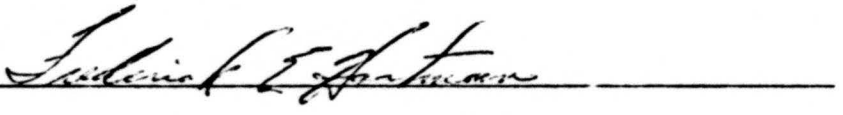
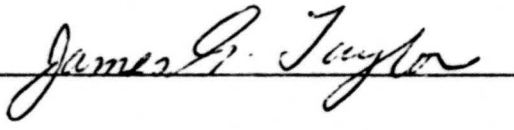
Author 

Approved by: 
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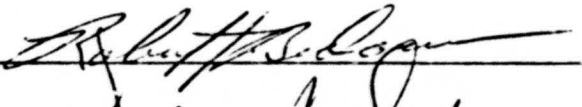
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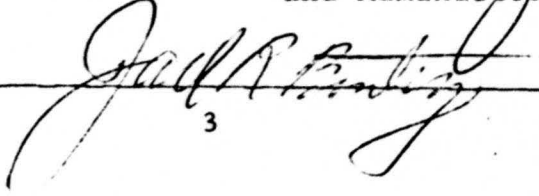
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ABSTRACT

In this thesis field artillery operations and fire support decisions are examined. The history of the development of artillery fire support systems is reviewed in order to provide insight into artillery missions. Standard tactical missions are identified and analyzed as well as fire planning and fire support coordination. A specific scenario is analyzed in detail with respect to the fire support decision process. This work attempts to provide the background information necessary for the construction of more realistic artillery models for use in a modern combined arms combat simulation.

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I. INTRODUCTION

The ultimate end of field artillery is fire. The basic mission of the United States Army Field Artillery, "is to provide continuous and timely fire support to the force commander." [14,3] Actually this "timely fire support" is given to the individual maneuver element, whether it is an infantryman or a tank. The wording is misleading, but it is quite common in military logic and writing to consider support to the unit, as, "support to the commander." Fire is the only reason for artillery's existence, and without supporting the maneuver forces, it literally has no reason for being. The proper use and employment of artillery on the modern battlefield is an exact science. As with any technical subject, the understanding of field artillery techniques and tactics, and the ability to make fire support decisions is acquired only through proper study and diligent application of the basic principles involved.

Since field artillery is used as a supporting element on the battlefield, it enters land combat simulations as part of combined arms problems. Land combat has been modeled in a wide variety of ways. There exist ground combat analysis models that were originally developed in support of specific Army analytic tasks. These models have evolved from simple differential equation, Lanchester-type models, to the high resolution simulations of brigade and division size units in

combat.[1,5] The major methodology of recent years has been the building of large unit models by integrating the outputs from separate small unit models such as CARMONETTE.[8,ii] This method of aggregation may be used to create division and theater level models of combat.

The analytic community studying Army problems generally has looked at the combined arms -- armor, infantry, artillery -- scenarios. Their technique has been the use of war games or combat simulations of varying degrees of complexity and detail. However, the high level (theater) war games often begin with input in the form of "firepower scores or other equally unconvincing indeces."[8,A-2] These firepower scores, "have by now been thoroughly discredited -- see, for example, the discussion in RAC-R-121, MEFORD, and RAC-R-145, EFC-II -- and an alternative must be found."[8,A-2] Although this source has made an excellent case against the use of fire power scores as input data, it goes on to suggest the building of a theater model by creating a theater-level war game composed of assessment output from the Division Battle Model, (DBM).[8,A-2] This idea is sound in theory, for a whole series of models could be combined and the final theater level war game would then be an aggregation of all the smaller component units.

As Barr pointed out,[1,6] there is a drawback in this "model stacking" approach. For instance, any errors or inaccuracies in the smaller unit models will be carried forward and perhaps even multiplied as several small unit

models are combined. The alternative to this error is to make the small unit models more and more detailed. This high resolution, however, does not come cheap. Observation of the amount of storage space and computer time required for the smallest high resolution models, impress the analyst that a high resolution model of theater-level conflict is not presently feasible.

The above discussion serves to identify the need for a more realistic, and practical approach to constructing theater level models of combat. This thesis does not try to build such a mathematical model. Rather, it addresses only one element in the combined arms combat team, the field artillery. This work investigates field artillery techniques, tactics, and fire support decisions.

It is hoped that this thesis will serve to assist future analysts in their attempts to model artillery fire as input in combined arms combat simulations. For this reason, considerable effort was placed in reconstructing a capsulized artillery chronology from various sources. As the following section on the historical development of field artillery makes clear, the conduct of war is an art based on fundamental concepts and principles. These principles have remained valid over the years, almost in spite of the prevailing weapons and tactics of the day.

It is imperative then, that a modern analyst at least be familiar with the development of the tactics and techniques of the artillery. Once this has been accomplished, it will

be obvious that using firepower scores, for instance, as artillery input in high level combat simulations is not realistically acceptable. But what is more important, these analysts will then have a better idea of how to improve this input, and make artillery a realistic component in an overall combat scenario.

As stated, this thesis does not attempt to present final, workable models for artillery in a combined arms scenario. It does try to provide valuable background information from various artillery sources in order to clarify and capsulize the considerations required in detailed artillery models. This thesis has done much of the background investigation in field artillery techniques and fire support, and can serve to point the way for future efforts to realistically model artillery as input for combined arms combat simulations.

II. HISTORICAL DEVELOPMENT

> "The value of military history is in the creative perception of the experience and lessons of the past, in the capability to disclose the regular laws, of the development of methods for the conduct of war, in its boundless capabilities for the expansion of the military thinking of officers and generals." [11,5]

This quotation from the works of A. Grechko, a noted Marshal of the Soviet Union, could be expanded to also include the effect of history on the military thinking of technicians and those analysts concerned with accurately modeling land combat in the modern military environment. This however, does justify the following section on the historical development of field artillery, and its inclusion in this analysis. For proper understanding of a phenomenon it is necessary to study its past. This helps to clarify the path of its development, and makes it easier to understand its interdependence and ties with other related phenomenon.[11,5] Military theory and its related analysis cannot ignore the past, for it is through history that isolated developments are placed in their proper perspective.

Former president, Dwight D. Eisenhower, in a letter to the United States Corps of Cadets on 22 April 1959, encouraged the study of military history to, "impart a level of military

experience and judgement", which one could not otherwise accumulate in a lifetime. [5,i]

A strong interdependence exists between current artillery techniques and the physical evolution of guns, ammunition, and fire support coordination. For these reasons the following chronology traces the development of artillery from the earliest known weapons to today.

A. ARTILLERY PRIOR TO CANNONS

The forerunners of modern cannon were war engines of primitive design. The earliest artillery pieces in general use were catapults, ballistas and later the trebuchet. The only real difference in these weapons and the modern artillery pieces was the nature of the propelling force that lofts the projectile toward the enemy. Manucy [10,1] documents the use of "ingenious machines" against the walls of Jerusalem in the eighth century B.C. These predecessors of the catapult and ballista used twisted ropes for the propulsion of solid stone projectiles. This early use of artillery as seige engines was to dominate the thinking of artillerists for nearly the next two thousand years. Figures 1 and 2 show the ballista and catapult as they were constructed in this early period. [19,2] The ballista had horizontal arms like a bow, and fired its projectile in a low trajectory like the guns of today. Some ballista fired arrows in the same manner.

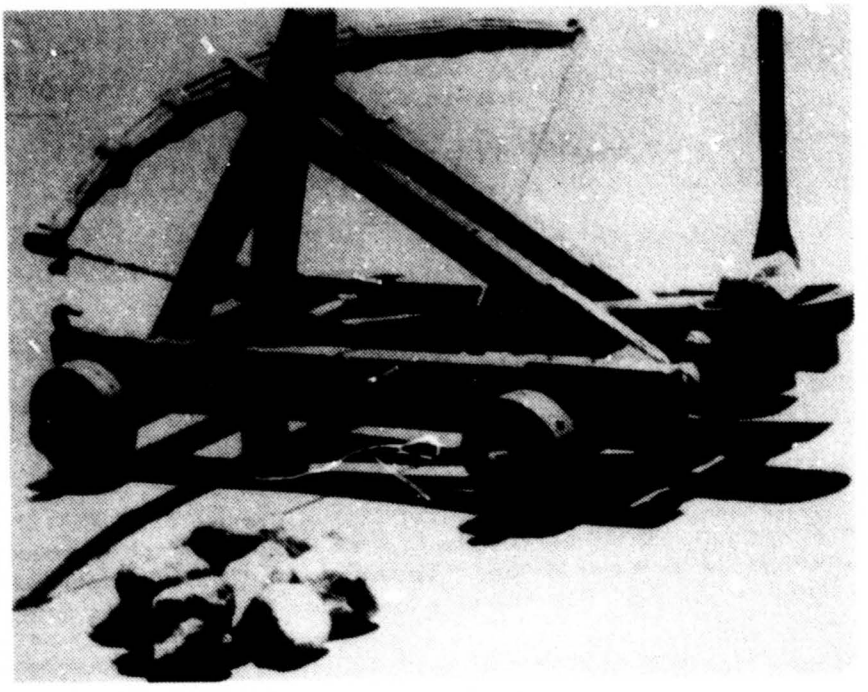


Figure 1. Ballista

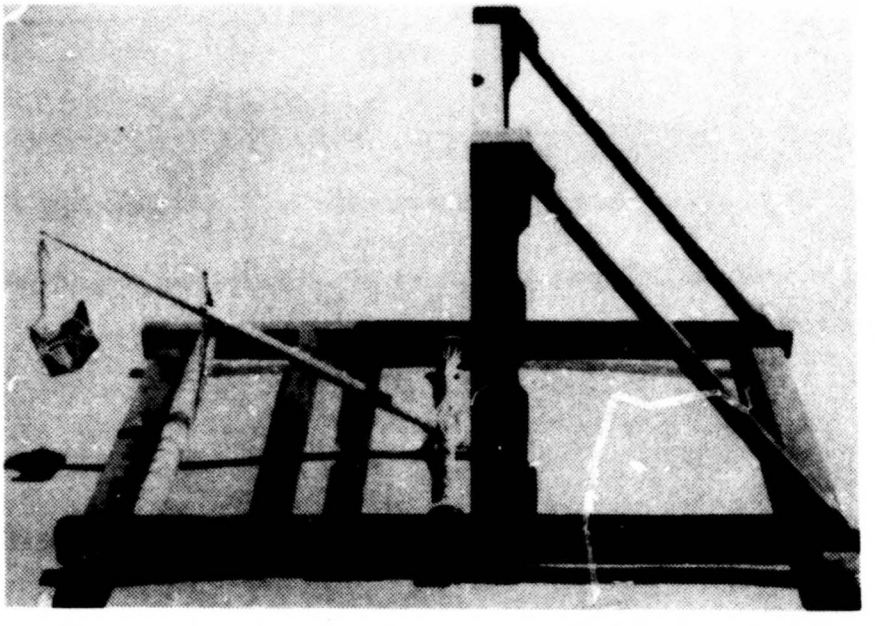


Figure 2. Catapult

Here it will serve the reader well to know that the three basic types of artillery weapons are guns, howitzers, and mortars. The guns have a low flat trajectory, and consequently generally have a higher muzzle velocity. The howitzer has a medium high trajectory between the extremes of the gun and the mortar. It represents the best features of the other two. The mortar has a very high (steep) trajectory. It generally lacks mobility in large calibers, but can attack specialized targets. The catapult was capable of hurling a one hundred-pound stone some 600 yards [10,1] much like the modern mortars.

It was not until the military genius of Alexander the Great in the fourth century B.C. that catapults were moved onto the battlefield to break up enemy infantry concentrations. [20,348] Before Alexander, artillery had been used exclusively in seiges. He can also be credited with introducing modern concepts of firepower, to include the artillery preparation on the objective prior to an attack by infantry. This tactic of using artillery, in the form of catapults, against maneuver forces was a scund practice, and indicates why Alexander was able to conquer much of the known world of his day before reaching the age of 33. Interestingly this highly effective use of artillery did not come into general use until almost the seventeenth century.

During the Roman seige of Syracuse (214-212 B.C.) the attackers learned the devastating effect of catapults turned against the beseiging force. [10,2] Archimedes, the Greek

mathematician engineered the use of artillery against the Romans and their ships from the fortified city. Unlike the example of Alexander the Great with mobile artillery, this principle of defending a fortification with artillery was widely received, and was practiced for centuries, even until the early days of our own country. Probably the most famous recent use of this technique was in the building of the Maginot line, a system of defenses built by the French along the German border between 1928 and 1939.

The techniques of seige and counter-seige with simple artillery held for centuries. In fact even after cannon were introduced, the catapult, ballista and trebuchets were used side by side with the early guns. The trebuchet was another war machine that received extensive use in the seige of medieval European castles.

B. DEVELOPMENT OF EARLY CANNONS

The next significant development in artillery came with the invention of gunpowder. It is known that the Chinese were producing an explosive mixture in very early times. The western world became at least cognizant of this substance as early as the fourth century A.D. A ninth century manuscript found in Europe contains a crude formula for gunpowder. [10,3] Primitive cannon seem to have existed in the orient as early as the twelfth century.

The Moors are credited with the first use of firearms in western Europe at the Battle of Saragossa in the twelfth

century. [10,3] They probably also introduced the original cannon, a small, wooden, mortar-like piece that resembled the later bombards of Europe.

It was not until the Hundred Year's War (1339-1453) that early cannon came into general use. These primitive weapons consisted of no more than iron or bronze tubes laid directly on the ground and elevated by the mounding of earth under the muzzles. [10,3] These weapons were grossly inaccurate, and were used basically as seige weapons. Of course such a use is obvious, since the time required for setting up and elevating the tube would be too great for attacking anything but a stationary target. Recall that the early catapults were also used primarily as seige engines; the parallel is obvious.

The race for building ever bigger bombards was furious during the fifteenth century. The largest caliber gun of all time, according to Manucy, was the Great Mortar of Moscow. [10,4] This weapon was built about 1525 and fired a projectile weighing a ton. The barrel was eighteen feet long and it fired a stone projectile thirty-six inches in diameter.

Early guns of this size spelled doom for the majestic, towering castles of Europe. Lower profile fortifications were built in the sixteenth century, and later these were abandoned in favor of reinforced earth works. Throughout the sixteenth century the technological improvements in metallurgy brought tremendous improvements in cannons. Coincident with these improvements in the art of casting were refinements

in the formula for making gunpowder, and the use of cast iron balls as projectiles. The improved casting techniques served to lighten the guns and at the same time make them stronger. This permitted the guns to be respectively more maneuverable and longer shooting. Trunnions were now cast on each side of the tube to aid in elevation, and permitted mounting on crude carriages to improve mobility.

Columbus brought the first cannons to this continent. In fact there was a literal baptism of fire for the New World. According to Manucy, the lookout on the "Pinta" first sighted land and fired a small bombard to notify Columbus on his flag ship, "Santa Maria". [10,5] Thus, from the very moment of discovery, artillery has played a part in the development of the Americas.

During the sixteenth century the ships continued to bring cannon to the New World. Not only the vessels were armed with guns though, the Spanish built numerous forts and armed them with ample weapons to defend their ownership of the treasures of America. In 1586 Drake took fourteen bronze guns from the fortification at St. Augustine. These highly ornamented pieces were of a variety of calibers and designs, all founded between 1546 and 1555. [10,5]

It was also during the sixteenth century that the first scientific treatise on gunnery was published. Many concepts appeared at this time, but because of a lag in technology, they were abandoned to wait for the proper materials and manufacturing processes. For instance, such improvements as

breech loading guns, and spiral rifling appeared in the 1500's but due to imperfections were discarded for the proven muzzle-loaded smooth bore type pieces.

Guns appeared on the battlefield rolling along in crude carts as early as the Hussite Wars of Bohemia (1419-24) [3,39] and once again the concept of using relatively light, mobile artillery on the battlefield against infantry type targets came into general acceptance. As with the development of tactics for the use of catapults, the deployment of cannon against soft, mobile targets depended on the right tactician and the right battle, coupled with the technical state of the art in weaponry. The sixteenth century was a difficult period for artillerymen. As the musket developed, the task of muzzle loading and servicing an artillery piece became increasingly hazardous work. In addition, the weapons themselves were extremely dangerous. It was common for artillerists to be injured by exploding weapons, muzzle bursts of the projectile, and delayed discharge of misfires. Even as artillery achieved use on the battlefield, most pieces were extremely heavy and their carriages were poorly designed and difficult to maneuver. The use of from ten to twenty horses to move a single gun was common practice and depended on the condition of the terrain over which the move was made, as well as on the size and design of the piece. Ammunition in this period was of three basic types. By far the most common was the solid ball. Usually this was a cast-iron round shot, but some solid stone shot were still being used at this point in

history. The bomb, a round iron shell filled with gun powder, was designed for basic use against personnel. Also anti-personnel in nature, but for closer ranges, were the cannister and grape-shot. The cannister was a cylindrical can filled with small projectiles. Musket balls were frequently used for this purpose. The grape-shot was a cluster of iron balls arranged symmetrically on an iron or wooden core. Sometimes this cluster was then covered with fabric to aid in storing and handling the projectiles.

A significant observation should be made here. During the four hundred or so years from the earliest cannon construction to this point in our chronology, the guns had improved dramatically. The early pot-de-fer (Fig. 3) had developed into guns that could throw shot almost as far as any gun used in the Civil War. [10,7] Breechloaders and rifled bores had been discovered and carriages and elevating mechanisms had been used. In other words, artillerymen now possessed at least the basic tools of the same arm that is today so devastating on the battlefield. The ingredient they lacked in 1600 was the technique of employment that make modern artillery the greatest casualty producer in conventional battle. It remained now only for the development of massed fire, increased mobility, efficient organization and tactical employment to place artillery forever supreme over small arms on the battlefield. Although this observation is quite simply stated, its actual evolution took over two hundred fifty years.

Figure 3. Pot de fer

C. CANNONS BECOME MOBILE

During the seventeenth century the Swedish warrior, King Gustavus Adolphus and his artillery chief, Lennart Torstensson devised a new battle plan involving extensive use of artillery and cavalry. [18,2] Artillery began to be employed with great mobility against soft targets much as it is today. This plan involved the use of lighter and more mobile artillery to smash the opposing infantry while the friendly cavalry neutralized the large, relatively immobile enemy artillery. With this need for mobility in his artillery, Gustavus removed all guns heavier than a 12-pounder from his field artillery. [10,7] Using this overall strategy Sweden soundly defeated the

Spanish at the Battle of Brietenfeld in 1631. The Spanish defeat was mainly due to the mobility of Gustavus' artillery, and the kings and generals of Europe rushed to develop light field guns for their own armies. Although this strategy was unique in its day, the concept was introduced by Alexander the Great many centuries before. Like Alexander, Gustavus also knew the value of fire concentration and initiated the techniques of massing his artillery in strong batteries against infantry targets.

In his quest for small, light artillery pieces, Gustavus developed a gun light enough to be drawn and served by only two men. This weapon was called the "leathern". [10,7] The gun was made by screwing a copper tube into a brass breech and covering the tube with layers of mastic and plaster to equalize the pressures of firing. This tube was then covered with a boiled, varnished leather sleeve to protect it from the elements, and accounts for the strange name.

Torstensson developed two artillery pieces vastly superior to the "leathern". His cast-iron four and nine-pounder demi-culverin were recognized as the ultimate field pieces of the day and led to complete abandonment of the leathern, because of its small allowable charge. The four-pounder weighed only about 500 pounds and was easily transported by a team of two horses. (Fig. 4) The light artillery of Gustavus looks remarkably like guns of a much later day, and was improved only slightly until the middle of the nineteenth century.

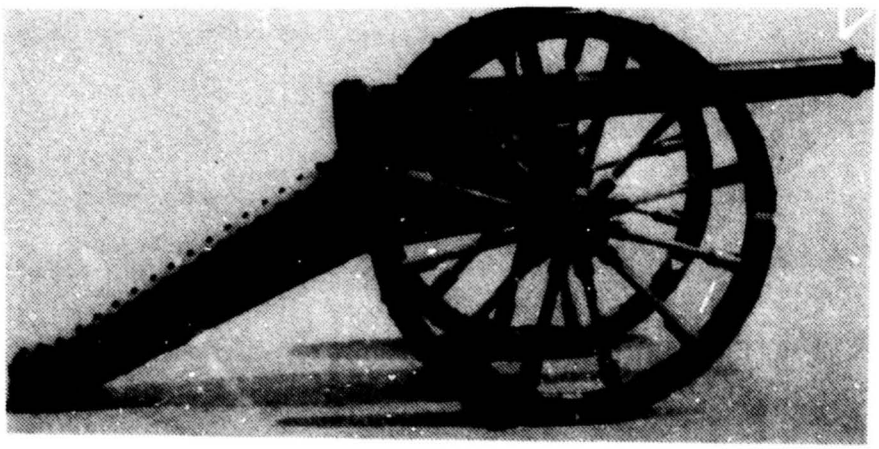


Figure 4. Cannon, 1650 Period

Also in the seventeenth century artillery began to be organized into permanent military units. Prior to this time the artillerists were like civilian tradesmen, and only their commander was a military officer. Louis XIV of France established schools of instruction for artillery in 1671 and raised a regiment of artillerymen. [18,2]

In the eighteenth century, Frederick the Great of Prussia became of necessity an innovator in artillery tactics. The gradual depletion of his veteran Prussian infantry in the Seven Years War (1756-63) necessitated a shift in tactics to rely more heavily on his artillery. [10,10] Frederick introduced the first horse artillery to follow closely, and support his highly efficient cavalry. Like Gustavus, Frederick's field artillery had only light guns and howitzers. The significant tactical contribution was his use of mobility and maneuver by positioning and repositioning of his batteries

according to the course of the battle. In other words, with his extreme mobility, he was able to truely influence the course of the battle by moving his field guns to the right place at the right time.

During the Seven Years War, Frederick defeated a combined French and German force that outnumbered him by three to one. By cleverly feinting retreat, Frederick drew the enemy into a salient and closed the trap by attacking with cavalry and firing many vollies from his horse artillery units who had moved into range behind the cavalry. [18,2]

The French artillerist, Jean Baptiste de Gribeauval brought back a number of ideas on artillery tactics after serving in the French force against Frederick. Although Gribeauval did not become Inspector General of Artillery until 1776, he revoluntionized French artillery, and vitally effected the artillery tactics of other countries as well. Gribeauval is regarded as the most outstanding artillerist of the 1700's and is responsible for the new tactics which Napoleon introduced so successfully. [10,11] Some of Gribeauval's innovations included the bringing up of artillery at a gallop behind the cavalry, thus gaining superiority of fire very quickly. He also reduced the length and weight of pieces with improved metallurgy, and improved carriages for both field and coastal guns. For coast artillery he used a traversing platform employing wheels on a track that greatly simplified the tracking of moving targets. [10,11]

Napoleon's artillery didn't use an artillery preparation to soften up the opposing infantry, but galloped up to fire cannister or grape-shot at almost point blank range. Columns of cavalry led infantry as they rushed in to exploit the opening made by the devastating close range artillery attack. Napoleon's artillery was smooth bore and muzzle loaded. Its ammunition was irregular and seldom fit true. Guns were traversed by shifting their trails and elevated with simple wedges. Since recoil mechanisms were still unknown, the direct fire pieces were relaid after each shot. [6,vi] Even without these modern refinements, much of Napoleon's success depended on his masterly use of field artillery.

D. AMERICAN ARTILLERY

Meanwhile there was also some historical significance in artillery in North America in the eighteenth century. One of the first artillery engagements was at Louisbourg when the French fort fell to a joint British and Colonial force in 1745. [3,39] With the storming of the great fortress of Louisbourg against, "long odds and logical military expectation," [3,16] Colonial artillerymen gained valuable experience and a lasting confidence that would serve them well in the Revolution.

Henry Knox was appointed Chief of the Continental Artillery on 17 November 1775. [18,3] Knox was a twenty-six year old book salesman from Boston, and even though he had been highly recommended to Washington, he was faced with problems

that would have challenged and taxed an experienced artillerist. The Continental artillery was faced with acute shortages of gunpowder, ammunition, and even of guns. [3,29]

The Colonies had depended upon England for gunpowder, so now with the outbreak of hostilities, all other sources were scoured for the precious grains. [3,29] The search for cannon was one of Knox's first concerns. A New York militia company raided a British battery on Manhattan Island in August of 1775, and successfully removed twenty-one nine-pounders. [12,38] Knox personally organized an expedition to move fifty-nine selected cannon a distance of three hundred miles in the dead of winter from Fort Ticonderoga to Boston. [3,32] On 24 January 1776, Colonel Knox presented General Washington with, "a noble train of artillery," [12,39] with which to bombard Boston. So effective were the American guns that the British set sail for Halifax on 17 March 1776 with Washington's guarantee of safe passage from the harbor. [12,39]

The Battle of Trenton on 26 December 1776 was an outstanding example of Knox's excellent grasp of artillery tactics. He moved his artillery in column with the infantry so they could be quickly put into action. [18,4] These tactics were successfully used by Frederick the Great some fifteen years earlier in Europe. Later Napoleon was to use this strategy to fully benefit from his mobile field artillery. In this battle, Knox so proved his ability as an adequate, even brilliant artillery commander, that he was promoted to Brigadier General on the twenty-eighth of December.

With the sources of importation cut off, the colonists began casting both bronze and iron guns. As gunpowder became more available, ammunition was manufactured to include bombs and case shot as well as the standard round shot and grape-shot.

At the Battle of Monmouth in June of 1778, General Knox massed his fire in concentrations of eight to ten guns at critical points on the battlefield. [18,5] The firing was so intense it was reported as, "the severest artillery fire ever heard in America." [3,57]

The final major artillery action of the Revolution was at Yorktown. In this final battle the Continental infantry moved forward to within four hundred yards and secured the movement of artillery forward to this devastating range. The combined artillery silenced the British guns until, "only a single mortar and a few coehorns still fired." [3,60] Here again we see Knox's brilliant use of the principles of mass and maneuver in classic artillery engagement. The Revolution had found American field artillery equal or superior to any artillery of the period. After the Battle of Monmouth, General Washington included the ultimate compliment in a General Order dated 29 June, 1778, "... that the enemy has done them the justice to acknowledge that no artillery could be better served than ours." [3,38]

As the United States moved into the nineteenth century many refinements were made in artillery gunnery and weapons manufacturing. The first American horse artillery drilled

for Congress on 4 July 1808. [3,64] Americans were now following the example of Gustavus and more recently, Napoleon in their attempt to stay up to date with their artillery techniques.

It was in the War of 1812 that Americans saw their first rocket fired as an artillery weapon. At Baltimore, the British fired rockets against the Americans, but lost the artillery battle anyhow. They were attempting to subdue Fort McHenry, a post guarding Baltimore Harbor. [18,6] This was incidently the battle that inspired the writing of our National Anthem, with its reference to the "rocket's red glare". The targets of the rockets were really the minds more than the bodies of the American infantry. The rockets appeared "to be darting directly at each watching soldier, making him shake in his boots,..." [3,71] Although the rockets were inherently inaccurate, they were relatively ineffective as a casualty producing weapon, even when they were near the target. The British also unveiled an improved anti-personnel round in this war. In 1784 Lieutenant Henry Shrapnel invented a spherical case shot with a time fuse to ignite the bursting charge. [3,75] This shell proved much more devastating than canister, grape or bombs.

The Artillery School of Practice was established in 1824 at Fort Monroe, Virginia. This was the first service school in our country, and provided translation of European artillery manuals and professional investigations of artillery techniques of the day.

The nineteenth century saw tremendous improvements in metallurgy, sighting equipment and ammunition. Although earlier attempts at rifling of cannon have been noted, it was not until 1846 that rifled iron, breech-loading cannon were independently produced in both Italy and Germany. [10,14] Rifling, of course stabilizes the projectile in flight by imparting a spin to the round as it travels down the tube. This allows the use of a longer, larger projectile and keeps the point facing the direction of flight, thus increasing accuracy and opening the way for point detonated fuses. Other advantages of a rifled projectile are the increased range, and greater striking energy.

In 1855 an Englishman, Lord Armstrong designed an artillery piece (Fig. 5) that employed many of the refinements of the preceding century. [10,14] The rifled, breech-loaded cannon was constructed with hoops shrunk over the tube to increase its strength. This "built-up" construction

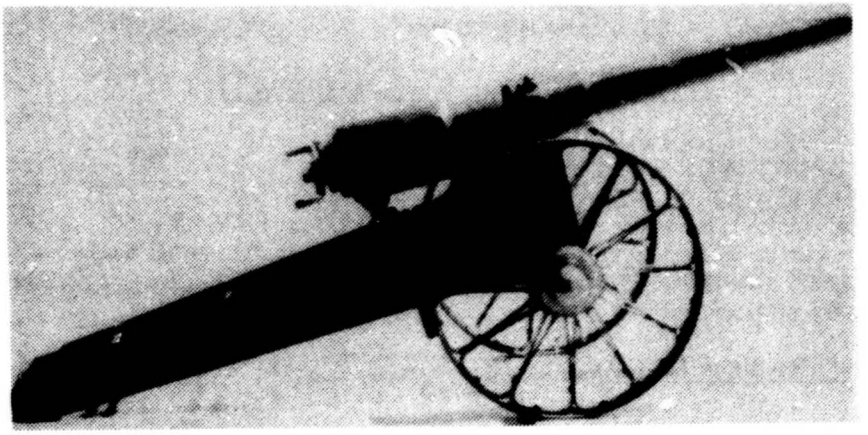


Figure 5. Cannon, 1855

permitted a great reduction in weight of the tube. Captain T. J. Rodman, an Army Ordnance officer, revolutionized the casting of gun tubes during the Civil War with a unique method of cooling. The molten iron was poured around a water-cooled core, allowing the inner walls of the tube to solidify first. As the outer metal cooled it contracted and compressed the inner layers imparting much greater strength to the tube to resist an exploding charge. [10,17] The popular "Parrot Gun" was invented in 1861 by Captain Robert Parrott, of the United States Army. It was a rifled iron cannon of built-up construction much like the English Armstrong. [3,119] This weapon was probably the most effective seige rifle in the United States inventory. [10,16] Cast-iron guns were to have a rapid replacement as techniques of casting and forging steel improved daily.

The Civil War was basically an infantry battleground, but artillery played an important role in many exchanges. The use of rifled small arms provided the infantryman with greater accuracy and range than the artillery, and permitted sharpshooters to pick off gun crews one at a time as they serviced their pieces. [18,8] The new rifled cannons were found to be ineffective in the Civil War for two reasons. First, unless they scored a direct hit, the shells burrowed into the soft earth and did little damage. An improved point detonated fuse was needed. The terrain of the forested, rolling, compartmentalized battlefields of the Civil War favored the muzzle-loaders with their larger rounds and shorter ranges.

The foremost field piece of this conflict was a muzzle-loading smooth bore modeled after a cannon designed by Napolean III. [3,120] Batteries of "Napoleons" were light, strong, and almost as mobile as horse artillery.

It has been said that during the Civil War, "artillery technology took a step backward." [18,8] This is a statement based on the increased use of smooth-bore, rather than rifled cannon, and it is not true in general. Even with the increased use of muzzle-loading smooth bores, the artillerists' use of classic principles was devastating in several battles. The deadly infantry fire of "minnie balls" served to force artillery farther to the rear and necessitated further development.

The battles in which artillery played an important role in the Civil War must be limited in this chronology. The interested reader is referred to the Battles of Manasses (First Bull Run), Shiloh, Richmond, Bull Run (Second), Antietam, Fredricksburg, Chancellorsville, Gettysburg and Vicksburg for excellent examples of artillery tactics, including the spectrum of tactics and use from seige to close defense. By the end of the Civil War new fuses were developed which caused the rifled projectiles to burst on contact, and the real potential of the rifled artillery's improved range and accuracy could be realized.

It is proper to place on record that the Confederates pioneered the organization and administration techniques that form the backbone of today's artillery units. They were the

first to break up grand army reserves and distribute artillery to the divisions, retaining only a Corps reserve. [2,94]

In the years following the Civil War until the turn of the century, the vital changes that took place in artillery can really be called the change into modern field artillery. No longer was the infantryman the greatest casualty producing element. In World War I for instance, artillery produced over seventy-five percent of the battlefield casualties, and became known as the "King of Battle".

Smokeless powder was developed by the Prussians in 1865. [3,179] The dense white clouds of burning black powder were now obsolete. Even though the smokeless powder offered advantages in enemy detection for counter-battery fire, the United States continued to issue black powder for "economic reasons" until its stock was exhausted. [18,10] This practice was to cost many American lives in the Spanish American War. Here the enemy, even though a third rate power, was using smokeless powder, and other up to date material.

Steel came into extensive use for gun founding and permitted the manufacture of steel carriages with recoil mechanisms, and breech-loading devices. These improvements should not be underestimated as they made the entire concept of indirect fire a reality.

Rifled cannon had by now completely superseded the smooth-bore for the advantages discussed earlier.

Improved sighting and laying mechanisms refined the technique of indirect laying, which had been used (somewhat

crudely), on a few occasions during the Civil War. [3,179] This method of firing removed the artilleryman from the sting of improved infantry weapons and permitted them to fire from protected positions on targets unseen by the gun crews.

Time and impact fuses were improved, making each artillery round more effective and lethal.

At the dawn of the twentieth century the basic pieces in field artillery were 3.2- and 3.6-inch guns and a 3.6-inch mortar. These cannon were even then obsolete when compared with the model 1897 of the French 75-mm gun. This weapon is considered the first in the modern family of artillery weapons, and the first weapon that could be practically used in an indirect fire role.

E. MODERN ARTILLERY EMERGES

It cannot be over emphasized that modern artillery techniques evolved as the guns and fire support equipment evolved. The overall evolution of modern artillery pieces was essentially completed by the turn of this century. Recall how the technique of indirect fire permits the guns to bring devastating fire on an enemy unseen from the guns. Without indirect fire modern artillery employment and tactics would be virtually impossible. Now consider the improvements in artillery material that were necessary to make indirect fire methods feasible. It was obvious that indirect laying was impossible without improved panoramic sights, quadrants, aiming circles, and azimuth instruments. Improvements such as

recuperators, rifled bores and improved fuses all had important roles in the development of indirect fire techniques.

The days of sighting a cannon at point blank range, over open sights had passed with the Civil War. [7,204] Improved technology made the guns more powerful and extended their range, so artillerists began firing at objects actually below the horizon or behind intervening obstacles. Even with such a need, as rifled bores helped create, indirect fire would have been impractical without an effective recoil mechanism. In his discussion of the French 75-mm, Farrow explains, "witnout a recuperator the gun would leap out of aim with each shot and have to be pointed anew." [7,152] So it was that even if an early cannon was laid for indirect fire, it would have to be relaid prior to each round. This of course would have made fire much too slow. The recoil mechanism, as introduced on the French 75-mm, was provided to absorb the shock of firing by allowing a certain retrograde movement of the cannon and then return it "into battery" for the next shot.

In 1907 field artillery was separated from coast artillery, and by Congressional decree the Field Artillery was defined as "that artillery which accompanies an army in the field and includes light, horse, seige and mountain artillery." [21,xxix] In 1911 Fort Sill, Oklahoma became the official home for artillery, when the School of Fire for Field Artillery was established there. [18,11]

World War I raised artillery to its rightfully important level on the battlefield. It was without question that artillery was now the greatest killer on the field of battle. The period of World War I saw many refinements in both the tactics and weapons of field artillery. The "preparation fire" was introduced and effectively softened the enemy objectives for the infantry. Artillery barrages and extensive massing of fires were also used in unique ways. This period also saw the introduction of chemical rounds, and the use of aerial observation to add a new dimension to observed fire. [18,13] Artillery also was influenced by developments in motor transport, signal communication, chemical warfare, tanks, aviation and mass production.

The French 75-mm gun was the best artillery piece of its type. It had a rugged recoil system that operated on glycerin and air, was light, easy to aim, and could fire more rapidly than any other piece of its day. Farrow claims the French 75-mm was, "the most useful and most used piece of artillery in the War." [7,151] The story of industrial mobilization and the phenomenal response of American industry to the artillery needs of the European battlefield is nothing short of amazing. The reader is referred to Edward S. Farrow's, American Guns in the War with Germany, [7] for an extremely detailed and statistically well documented report. Suffice it here to say that gun makers turned out more cannon in this period in the United States than had been seen in all previous history, and, "for every gun of another size produced,

the United States also turned out a 75-mm." [7,151] The 155-mm howitzer was the other of the two best known weapons of the War. This howitzer's development dates back to the nineteenth century, but its design by the French had, "so strengthened the structure, and increased the range and increased the serviceability," [7,157] that it remains a basic artillery weapon in today's army, having been only slightly modified from its earliest days.

During the period between the World Wars the field artillery saw many refinements and improvements. Motor transport had almost entirely replaced horses and many weapons were self-propelled. Many of the improvements had developed from lessons learned in World War I. The introduction of armor in that war had caused artillerymen to once again turn to larger calibers. Now, however, transporting these large guns was not the impossible task it had been in earlier days.

The tactics of field artillery were basically the same as during the Civil War. Mobility, massing of fires, flexibility of control and accuracy of delivery remained the basic considerations. With the development and improvement of the fire direction center (FDC), devastating concentrations of fire could be delivered. The fire direction center method of conducting fire permitted the concentration of two or more artillery units on a single target. When the fire from perhaps as many as one hundred guns is accurately directed and speedily shifted on the battlefield, the principle of mass is epitomized.

Weapons had been refined, with the greatest improvements in sighting and firing equipment. The 105-mm howitzers were in the hands of the troops in World War II and eventually became the standard light artillery weapon of the United States, and has remained in that status for the last thirty years. This weapon was a great improvement over the venerable French 75-mm that it replaced. Its rugged carriage was built with a unique system of pivots on the lower carriage to enable placement of the gun on a sloping hill side without effecting the level plane of the upper carriage, and tube. [12,157] The strong, powerful 155-mm howitzers were modernized and equipped with pneumatic tires to serve once more, throwing a 95-pound projectile at a sustained rate of fire of one round per minute.

The American arsenal was further augmented by improving the 155-mm guns, by 8-inch howitzers and 8-inch guns (ranges of 12.3 and 24 miles respectively), and the enormous 240-mm howitzer. [3,239] An American invention, the proximity (variable time) fuse provided a great advantage in the lethality of antipersonnel rounds. The fuse contained a tiny electronic sensor that exploded the projectile when it came into the "proximity" of any object of sufficient mass. In addition to its deadly effect providing low air bursts over soft targets on the ground, it greatly increased the effectiveness of anti-aircraft fire, since direct hits were no longer required to kill the target. [3,239]

An accolade for American field artillery was given after the War by General of Artillery, Karl Thoholte, of the German Army.

> "In technology, the American excells. The standardization of pieces, the quality of the ammunition, and communication equipment, and the adjustment of fires on battery and division artillery level are superior. ... use of the proximity fuse before any other nation brought it into action needs no further praise." [3,253]

The American artillery had served admirably on both fronts. An example of just how effective the artillery was in massing fires in the Pacific was evident on Okinawa in April 1945. In an attack on the Shuri Line, "the greatest concentration of artillery every employed in the Pacific war," [3,267] led the preparation for the assault. Twenty-seven battalions of artillery from 105's to 8-inchers, totalling 324 pieces thundered down on the enemy. [3,267]

Further discussion, to include the cannon delivery of an atomic shell, guided missiles and computerized fire direction such as FADAC and TACFIRE would serve little to actually improve this chronology. In the evolution of modern artillery through the twenty-seven centuries of this account, it has progressed from catapult, to bombard, to smooth bore, to rifled cannon. Just since World War II the field artillery progressed from simple cannon to guided missiles with nuclear warheads capable of the destructive force from countless

conventional battalions of guns. Which step was a greater one? This question can be answered only in the mind of the reader.

At least the historical development since 1945 has the advantage of recent history. It is much more easily understood since the events took place within most analysts' lifetimes. The basic reason for stopping this account at the conclusion of World War II was that the more recent developments did not add anything to the following analysis. The following section limits itself to a conventional, non-nuclear tactical situation. The use of modern field artillery missiles was not discussed, and FADAC and TACFIRE are merely tools that assist the decision maker. They do not influence his actual decisions.

Conclusively, it can be said that by the end of World War II the concept of modern artillery employment had developed brilliantly, and with the exception of tactical nuclear weapons, and cannon-fired guided projectiles those tactics serve well the following analysis. Granted, the helicopter has been used to provide undreamed of mobility to 105's and 155-mm howitzers, but once in position their rules of employment have not been greatly altered. These two weapons are almost identical to those howitzers in the hands of artillerymen from 1941 to 1945, and they are still capable of the fine record they amassed during that period.

III. FIRE PLANNING AND FIRE SUPPORT COORDINATION

A discussion of modern field artillery must address a number of preliminary facts as background. In the preceding section a chronology of field artillery was presented; beginning with the earliest recorded history, to that point in the recent past which included all developments necessary for a look at conventional techniques and employment.

In the historical section, it was seen that the techniques of employment and tactics, and the fire support considerations in use today evolved over many centuries, and depended directly on the degree of sophistication in the weapons at that time. A strong case was made that modern artillery, simply could not exist without the technique referred to as indirect fire. The traditional concepts of employment were based on the effect of direct fire at relatively close ranges. The United States mountain artillery as late as the early 1900's was still using direct fire techniques. Field artillery pieces of the period were thus described, "The front sight is a plain roughened steel point sight, and is permanently fixed to the right rim base." [4,5] A gunner's quadrant was placed directly on the tube of the weapon to determine the proper firing elevation, and the following quotation at least alludes to something other than direct fire, "the gunner's quadrant is thoroughly reliable both for direct and curved fire." [4,6] This traditional direct fire mode is still

employed in cases of close-in fighting around the guns. As the recent Viet Nam experience illustrates, the use of improved munitions such as the "beehive" round were extremely effective against masses of infantry personnel in assault formation at close ranges.

However, the ability to provide "continuous and timely fire support," [14,3] as the basic mission of the artillery claims, requires indirect fire capability, fire direction centers (FDC's), and a common grid to permit massing and lateral reinforcing of artillery units. Although one of the capabilities of the artillery is direct fire, as it has been since use of the very first cannons; today indirect fire permits a whole spectrum of fire support, to include: the rapid shifting of fires, massing of fires of several units, firing from and into defilade, accurate fires without adjustment (with prior registration), and aerial fire support.

The chief difference between the old and the new in the use of artillery fire is, "the degree of precision attained." [7,204] The early artillery fired relatively blindly, and placed reliance on the sheer volume of artillery fire, while modern artillery techniques take advantage of increased accuracy and effectiveness to better support the maneuver elements.

A. STANDARD TACTICAL MISSIONS

Before discussing fire support, it is necessary to look at the four standard tactical missions assigned field artillery units, for this assignment dictates the fire support

responsibilities of a particular unit. There are four standard missions which may be assigned to a field artillery battalion: direct support (DS), reinforcing (R), general support reinforcing (GSR), and general support (GS). [14,10] (Appendix B) These missions provide varying degrees of centralized control under the force artillery commander, and varying degrees of responsiveness to the needs of the supported maneuver unit commanders.

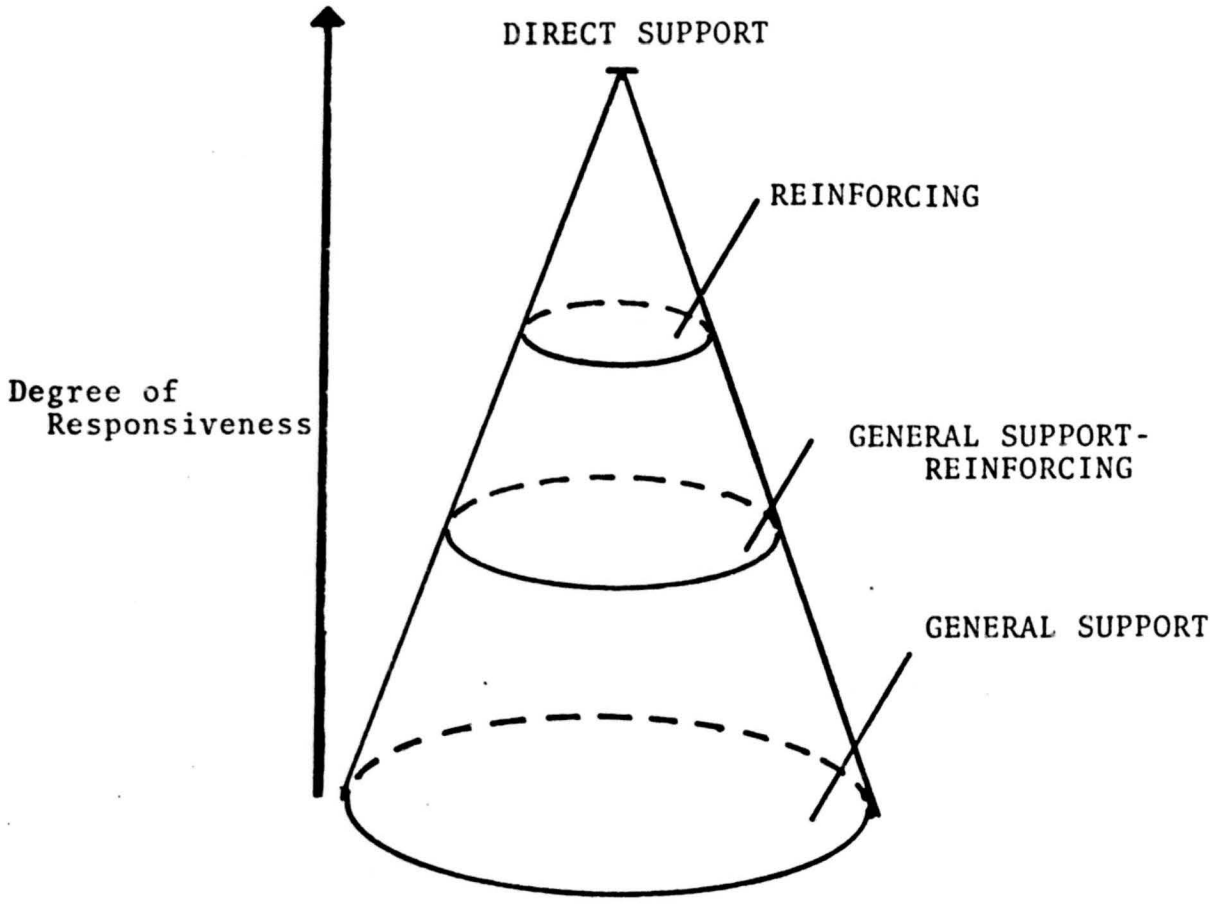


Figure 6. Cone of Responsiveness

Figure six shows the relationship between each of the four standard tactical missions and their ability to respond to the fire requests of a particular unit. Note that in the DS role, artillery has immediate response to the smallest maneuver unit commander, whereas in the general support, the artillery is in support of the entire operation, and does not fire until the large unit commander gives it a specific mission. Centralized control and responsiveness are opposing quantities. As one increases the other must decrease.

Understanding of the four tactical missions facilitates the grasp of concepts and tactics of modern field artillery. As each mission is addressed, the term centralized control will be referred to as a desirable quality. When control is centralized at the highest level appropriate, field artillery becomes more efficient. Flexibility in employment, massing of fires, and uniformity of support are all gained when the large unit controls the fire. In some situations such as the fast moving offensive operation, the artillery must be responsible to the small maneuver unit commander, and the direct support mission is appropriate. The degree of responsiveness in the assault necessitates a decrease in the control by the overall commander of his artillery assets.

The direct support mission provides the least centralized control, and the greatest responsiveness to the maneuver unit's requests for fire. Although the DS artillery unit remains under the command of its next higher artillery unit commander, its mission requires continuous availability to

support the maneuver element, so close coordination and planning must exist with the supported headquarters. The most typical DS role places an artillery battalion in support of a maneuver brigade. The sector of fire for this artillery is determined by the boundaries of the supported maneuver unit. Generally the three firing batteries of an artillery tube battalion are assigned direct support missions for the three maneuver battalions in the brigade. This relationship is maintained as long as it is tactically feasible.

The reinforcing mission refers to the reinforcing of artillery fires by another artillery unit. Artillery always reinforces other artillery units, and supports maneuver units. The mission of reinforcing is used to augment the fires of another artillery unit. The reinforced unit plans and controls the fires for the reinforcing unit, even though the R artillery remains under its own command channels. The sector of fire for this artillery is determined by the sector of fire for the reinforced artillery unit.

The mission of general support - reinforcing allows a certain amount of centralized control. In the general support portion of this composite mission, the artillery furnishes fire support to the force as a whole and additionally reinforces another artillery unit. Priority of fire goes to the force artillery headquarters rather than to the reinforced unit. This mission is the most flexible of the standard tactical missions. Here, the sector of fire depends on its assigned fire support area.

An artillery unit supports the force as a whole, and maximizes the quality of centralized control with an assigned mission of general support. These units are part of the force commander's personnel, "hip pocket" artillery, to remain available for influencing the combat at the time and place the commander deems appropriate. In a GS role, the area of fire is the entire force sector, until a specific fire support mission is assigned.

The basic missions may be modified to fit a particular operation or a special situation. The discussion of artillery fire support must include fire planning, and fire support coordination. In a combined arms operation artillery fire support is only one of the types of fires available. In most operations, the maneuver force will have fire support available from one or more of the following: attack helicopters, close air support, and naval gunfire. Artillery support is further broken down into aerial artillery, cannons, and missiles; all with both conventional and nuclear rounds and war heads. In this analysis we will consider only cannon artillery in the conventional fire support role.

Fire support and maneuver must be coordinated to a high degree. In many instances the very success of a combat force depends on proper planning and coordination of the firing units and the maneuver elements. It is the responsibility of a field artillery fire support coordinator (FSCOORD) to integrate the efforts of all fire support means available - including those from the sister services.

B. FIRE PLANNING:

Fire planning is exercized at all levels from company to field army. It will serve here to note that artillery fire can be classified as against planned targets or targets of opportunity. These planned targets are either scheduled -- fired at a predetermined time, or on-call -- fired on request. On-call targets are planned targets as contrasted with targets-of-opportunity which are not preplanned, but none the less are important sources of support. The degree of detail and length of the fire support annex are limited only by time. The fire planning is a continuing process that constantly refines and updates targets until the operation is concluded. Each level consolidates all targeting information and passes it to the next higher fire support coordinator to provide a detailed aggregation of targets and priorities for the force commander. (Fig. 7) (Appendix C)

Fires are planned in support of combat operations, both offensive and defensive in nature. Because of the different techniques involved, fire planning for the offense will be discussed first. Both types of planned fires should cover critical areas, such as enemy locations (whether confirmed, suspect, or likely), and prominent terrain features (such as hill tops or road junctions). In essence, fires are planned to hinder the enemy and deny him ground, and to prevent enemy influence on friendly maneuver units.

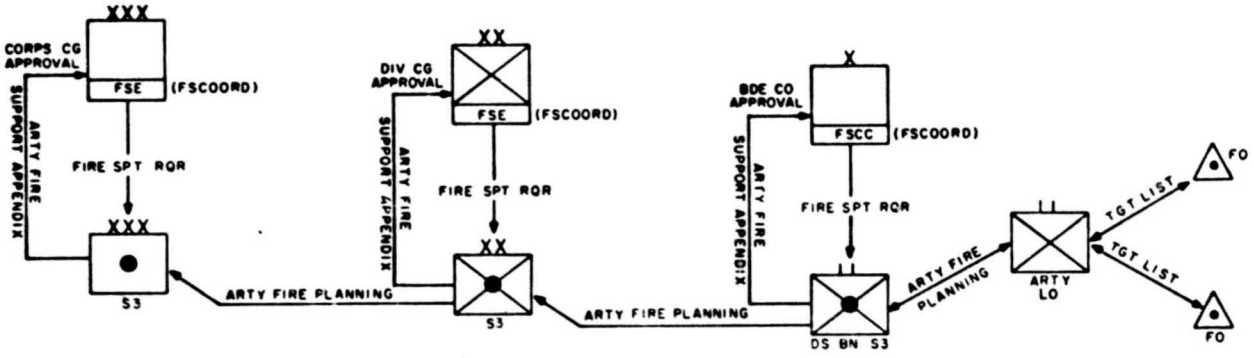


Figure 7. Artillery fire planning channels

Legend: Infantry Battalion---⊠ Brigade level unit-- X

Artillery Battalion--⊗ Division level unit- XX

Corps level unit-- XXX

In an offensive operation artillery fires are planned to engage the enemy before the artillery preparation,during the preparation, and during the attack. The first category of fires includes such fires as: targets-of-opportunity, covering fires for the deployment of the attacking force, registrations, and harassment. The latter is provided to pin down the enemy and disrupt his communications and command channels. Care must be taken in this phase of support of offensive operations to insure that the impending attack is not prematurely disclosed.

The artillery preparation is, "prearranged fire delivered in accordance with a time schedule in support of an attack." [16,6] The maneuver unit commander decides whether or not to fire a preparation, and how long and intense it should be. The time length of a preparation is dependent on the degree of surprise desired, the available ammunition, and the number of targets. Its duration can be anywhere from a few minutes to several hours depending on the particular objective to be attacked. The force commander can consult his fire support coordinator for the calculation of a standard equation that gives an excellent example for the minimum time required.

$$T = \frac{X \times P \times M}{N} \qquad [16,7]$$

where: T = The time length of the preparation.

X = The number of targets to be scheduled.

P = The planning time, the total time in minutes required per target.

M = The method of attack, the number of batteries employed.

N = The total number of artillery batteries available for employment.

It should be emphasized that since average values are used for planning time, the final time length of the preparation is only an approximate, minimum value.

Phasing is used in a preparation to permit the attacking of priority targets early, and to better support the maneuver force. The initial phase includes counterbattery fire and

enemy observation posts. The second phase includes the attack of command posts, lines of communication and known or suspected enemy assembly areas. The phase just prior to the assault should concentrate on the enemies forward defensive areas.

During the attack by the maneuver force the fire planner considers those targets that will assist the advance of the supported unit. These targets can be further classified as in-front-of, beyond, and on the objective. These fires too are fired in phases consistent with the progress of the friendly unit. The fires planned in-front-of the objective engage enemy observation posts, forward defensive positions and weapons locations; to assist the advance of the maneuver force. Of course these targets must be attacked before the friendly advance comes within the danger region. It is extremely important that the fire planner monitor the progress of the friendly maneuver forces to insure that over-run targets are not brought under fire.

Those targets planned on the objective are fired next to destroy or neutralize enemy resistance against the final assault of the maneuver unit. Of course forward observers moving with the maneuver force will be firing targets-of-opportunity as they appear. These fires cannot be planned ahead of time, but are extremely important in the overall support scheme.

The area beyond the objective is covered with planned fire and attacked after the other two phases mentioned. Those

fires planned beyond the final objective of the friendly maneuver force serve to protect the friendly unit during its reorganization on the objective. These fires cover likely avenues of approach that could serve the enemy in launching a counterattack. They also serve to prevent the enemy from reinforcing or reorganizing his disengaged forces. See Figure 8 for a summary of offensive fire planning.

PHASES OF FIRE	TARGET CATEGORIES
1. Fire before the preparation.	1. Targets of opportunity. Covering fires for maneuver. Registration. Harassment and interdiction.
2. Preparation Fire.	2. Counterbattery and enemy OP's. Fires against enemy command posts and communications. Forward defensive positions.
3. Fires during the attack.	3. Forward positions and OP's. Objective area. Enemy avenues of approach. All preceding categories as time and ammunition permit.

Figure 8. Offensive fire planning

In defensive operations artillery fire has an equally important role as in the offense. Defensive artillery fire is planned in several phases. Basically their goal is to

engage targets before the enemy can organize for an attack, while the enemy attack is in progress, and to support a friendly counterattack. [16,9]

Those fires planned for delivery prior to the enemy attack include harassing and interdiction, in order to precipitate an early deployment by the enemy; and fires in support of friendly security elements, such as patrols placed forward for early warning.

Counterpreparation fire is also considered in this category of fire planning. The counterpreparation is, "intense prearranged fire delivered when the imminence of the enemy attack is discovered." [16,10] The artillery counterpreparation is planned to break-up and disorganize the enemy, and decrease the effect of his artillery preparation. This action, if successful, blunts the enemy's offensive action and in the ideal case, either delays or cancels the impending attack.

The first priority in a counterpreparation is given to counterbattery targets, forward maneuver elements, and enemy observation posts. Next, the lines of communication, command posts, reserves, and resupply facilities are fired upon.

The decision to fire a counterpreparation is made by the maneuver force commander. The timing for this fire is most critical. For example, if the counterpreparation comes too early, friendly artillery locations are revealed and little damage is done. If fired too late, there will be no need for

a counterpreparation at all. The units will be involved defending against the actual enemy attack.

When the enemy successfully gets into position to initiate his attack other planned fires should be delivered. These fires attempt to break up the enemy attack formations, and limit the extent of his penetration. The fires delivered during attack are the final protective fires (FPF's), and the requests from forward observers on targets-of-opportunity.

The FPF is a stationary line of targets around the outer perimeter of a friendly unit. This prearranged barrier of fire integrates all available fire power along a defensive line to protect the friendly unit. The shape and depth of the FPF is varied to fit the appropriate maneuver forces and the caliber of the supporting weapons. All artillery gives absolute priority to calls for firing the FPF, and direct support artillery set their guns on the appropriate elevation and deflection of the FPF any time they are not engaged in other fire missions. It is the responsibility of the artillery forward observer to adjust fire, piece by piece on the desired location in the FPF. (Thus each gun is literally fired-in.)

Another type of fire planned for defensive operations is the targets supporting a counterattack. These targets must be closely coordinated with the maneuver elements to insure adequate support. In planning fires for a counterattack, the fire planner tries to stop or blunt the nose of the enemy penetration, and to seal off the base of the penetration to

prevent the enemy from either reinforcing or withdrawing his forces. See Figure 9 for a summary of defensive fire planning. Once again the fire support coordinator must remain abreast of the movement of the friendly maneuver force to cancel those targets behind their line of progress.

PHASES OF FIRE	TARGET CATEGORIES
1. Fires before the enemy can organize.	1. Counterpreparation. Counterbattery and enemy OP's.
2. Fires during the attack.	2. Targets of opportunity. Final protective fires.
3. Fires during the counter-attack.	3. Targets of opportunity. Blocking and channeling of the enemy.

Figure 9. Defensive fire planning

Two additional types of fire should be mentioned here: Barrage fire is a technique devised to fire into a pre-arranged area to literally fill the space, rather than to be aimed at specific targets. [16,12] The use of barrage fire is not an efficient use of ammunition, since it requires very large amounts of ammunition for limited casualties. Barrage fire is not frequently used by the United States Army. Counterbattery fire has been mentioned several times earlier.

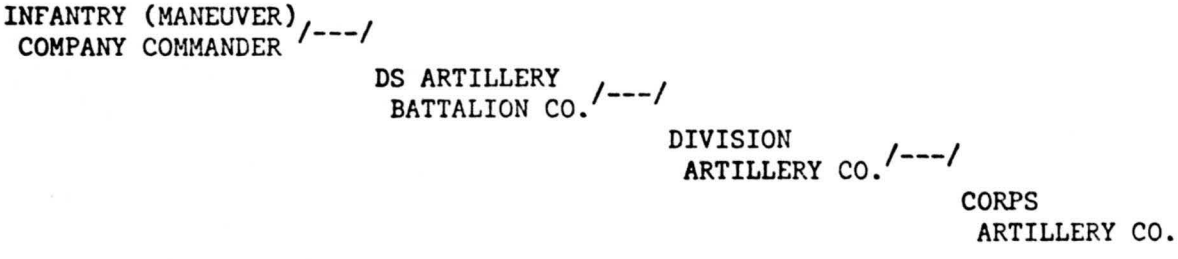
This fire is adequately explained by its name. It is that fire, "delivered for the purpose of destroying or neutralizing indirect fire weapons systems." [16,13] Counterbattery targets are always given very high priority by the fire planners for obvious reasons.

It has been shown how artillery fire planning is important in both offensive and defensive operations. The artillery fire support is used in a manner consistent with the actions of the supported unit. During this discussion of fire planning, numerous references were made to the fire support coordinator. Fire support coordination ties in with fire planning channels, and it is necessary to the understanding of artillery decision making, to have a firm concept of how a fire support coordinator fits into the overall scheme of artillery fire support.

C. FIRE SUPPORT COORDINATION

Fire support coordination, "is not a new procedure or technique; its basic principles have existed for many years." [17,1] As the modern battlefield saw improvements in the speed and range of delivery systems, the use of close air support, the increased lethality of weapons, and the greater mobility of modern maneuver units; it became obvious that each level of command must have some one coordinate the fires available to the commander, and advise him as to their use. It is only at the lowest level, that the maneuver company commander is himself the FSCOORD, but even here the

artillery forward observers are available for advice and assistance. At battalion level and higher, an artilleryman serves to coordinate fire support. (Figure 10)



Note: At all except the lowest level, the artillery commander is responsible.

Figure 10. Fire support coordinators

Fire support coordination is defined as, "planning and executing of fire, so that targets are adequately covered by a weapon or group of weapons." [17,2] This definition indicates how fire planning and fire support coordination are closely related. The preceding section on fire planning addressed only that phase. The FSCOORD however, is concerned with execution as well as the planning of artillery fires.

The fire support coordinator is responsible for advising the force commander on all fire support matters, to include the complete friendly artillery capacity and the extent of the enemy artillery threat. At the lowest level, the maneuver company, the company commander coordinates his own direct support artillery fire and mortars, and integrates their fire into his particular scheme of maneuver. The

company commander is advised by his artillery forward observer, who is more familiar with the capabilities and limitations of the available artillery. The company commander has more overall experience however, and takes responsibility for fire support decisions at this level. The fire planning at the maneuver company level is consolidated in the form of target lists from his artillery and mortar forward observers by the maneuver company commander. The artillery FO then submits his target list to the fire support officer at the maneuver battalion. (Appendix C)

The fire support officer at the maneuver battalion is an artillery officer, usually from the artillery unit (DS) supplying the fire support. The FSCOORD at this level is responsible for compiling target lists and determining the fire support needs of the maneuver battalion. He also acts as an advisor to the maneuver battalion commander and his staff on artillery matters. He combines target lists from the three maneuver companies and submits an overall fire support requirement and target list to the direct support artillery battalion. See Figure 7 and Appendix C.

The artillery battalion S-3, operations officer, has an extremely important role in decision making at this point. He is responsible for the battalion fire direction center (FDC) and has the authority to determine what targets will be fired upon, and with what weapons, and at what time. The DS artillery battalion S-3 receives target lists from the

three maneuver battalions in the brigade and also their fire support requirements. He also receives target information and instructions from the next higher command. In this case from division artillery.

At this level, a FSCOORD advises the brigade commander and closely coordinates with the DS artillery battalion. The commander of the artillery battalion in direct support has overall responsibility for this, and physically serves as the fire support officer for the brigade.

Fire support coordination is handled by a more formal arrangement at division and higher levels of command. At division, corps, and field army levels, this coordination agency is referred to as the fire support element. (FSE). [17,4] The FSE is responsible for all the coordination measures that were earlier discussed at the lower levels. The artillery commander traditionally serves as the FSCOORD for the next higher maneuver unit commander. For example, division artillery is a brigade size organization supporting a maneuver division. The division artillery commander serves as the primary advisor in artillery matters for the division commander. This relationship has already been discussed at the brigade level, supported by an artillery battalion.

The maneuver commander is the ultimate decision maker as to whether or not fire support is used, and sometimes even as to when it is to be employed. However, the artillery fire support coordinators make the qualitative decisions in specific target considerations. The questions of priority,

amount of fire support required, and type of fire support with which to attack a specific target; are decided by the fire support coordinator.

Determining the priority with which targets are attacked is an important function of a FSCOORD. As earlier discussion of offensive and defensive fire support indicate, certain time phases are commonly used in fire planning, and this gives at least broad priorities to individual targets. The yardstick that basically determines the priority of a target, is the value, or military importance of that target. This value can be determined by analyzing the potential threat to friendly forces if the target is attacked, or considering the material advantage gained toward accomplishment of the mission if the target is destroyed early.

A system of priorities has been devised to assist the FSCOORD in his targeting decisions. These extend from Priority I; defined as, "Targets capable of preventing the execution of the plan of action." [16,32]; to Priority IV; defined as, "Targets capable of limited interference with the execution of the plan of action." [16,32] These priorities seem to have been intentionally written in very nebulous terms to be generally applicable to any tactical situation. This wording does allow artillery decision makers a great deal of flexibility in tailoring their fire support to a specific scenario. This discussion of artillery fire planning, and the role of the fire support coordinator should prove

valuable to any detailed analysis of field artillery decision making. The final portion of this thesis will indicate how some of these facts are fitted into a combined arms combat scenario.

IV. SCENARIO PRESENTATION AND DISCUSSION

In the historical development section of this thesis, it was shown that modern field artillery has evolved over many centuries to reach its present level of refinement. A great deal of effort was devoted to developing the idea of the concurrent evolution of artillery techniques with artillery weaponry. The chronological development indicates the changes and improvements in weapons, and thus traces the progress and changing tactics in artillery.

The earlier discussion of fire planning and fire support coordination was an attempt at capsulizing the fire support decisions and decision processes that are necessary in the employment of modern cannon artillery. As with the historic section, numerous references were consulted, and those items considered relevant to this work have been included.

In order to better identify the fire support considerations and decision makers, the following general combat scenario is presented. As was stated in the introduction, this thesis does not attempt to build a unique working combat model, nor does it even propose to improve existing ones. Rather, it attempts to contribute that material considered necessary to the realistic modelling of artillery.

Artillery is an area fire weapon, in that it is effective against a given target area rather than a specific point type target. Artillery can be used in a destruction role, in

which a specific object, usually a bunker or other immobile target is fired upon until destroyed. The primary use of artillery, however, is in its area fire role. The optimal (and most frequently considered) use for artillery is against personnel targets with little or no protection.

Although a complete combined arms scenario is usually considered by those analysts interested in models of combat, this thesis is directed only toward the artillery portion of the combined arms team. Consequently, the scenario is fully discussed only as it regards the artillery fire support decisions. Consider a conventional, brigade level combat force (Blue) in a deliberately prepared defensive position. See Figure 11 for the disposition of Blue forces. An aggressor (Red) force mounts a combined arms attack against the friendly defensive unit with a force of undisclosed size. The following scenario will include the decisions made by the Blue forces in a defensive posture. The scenario will be terminated after the discussion of a Blue counterattack.

The Blue brigade occupies a sector of the battlefield with three maneuver battalions on line. (Fig. 11) In this scenario that force size is approximately 1500 combatants. A battalion of towed, 155-mm howitzers is in direct support of the brigade, with the three firing batteries each in direct support of the three maneuver battalions. Although the single artillery piece discussed here is the 155-mm howitzer, a mathematical comparison of effectiveness permits a complete range of information for the other field artillery weapons.

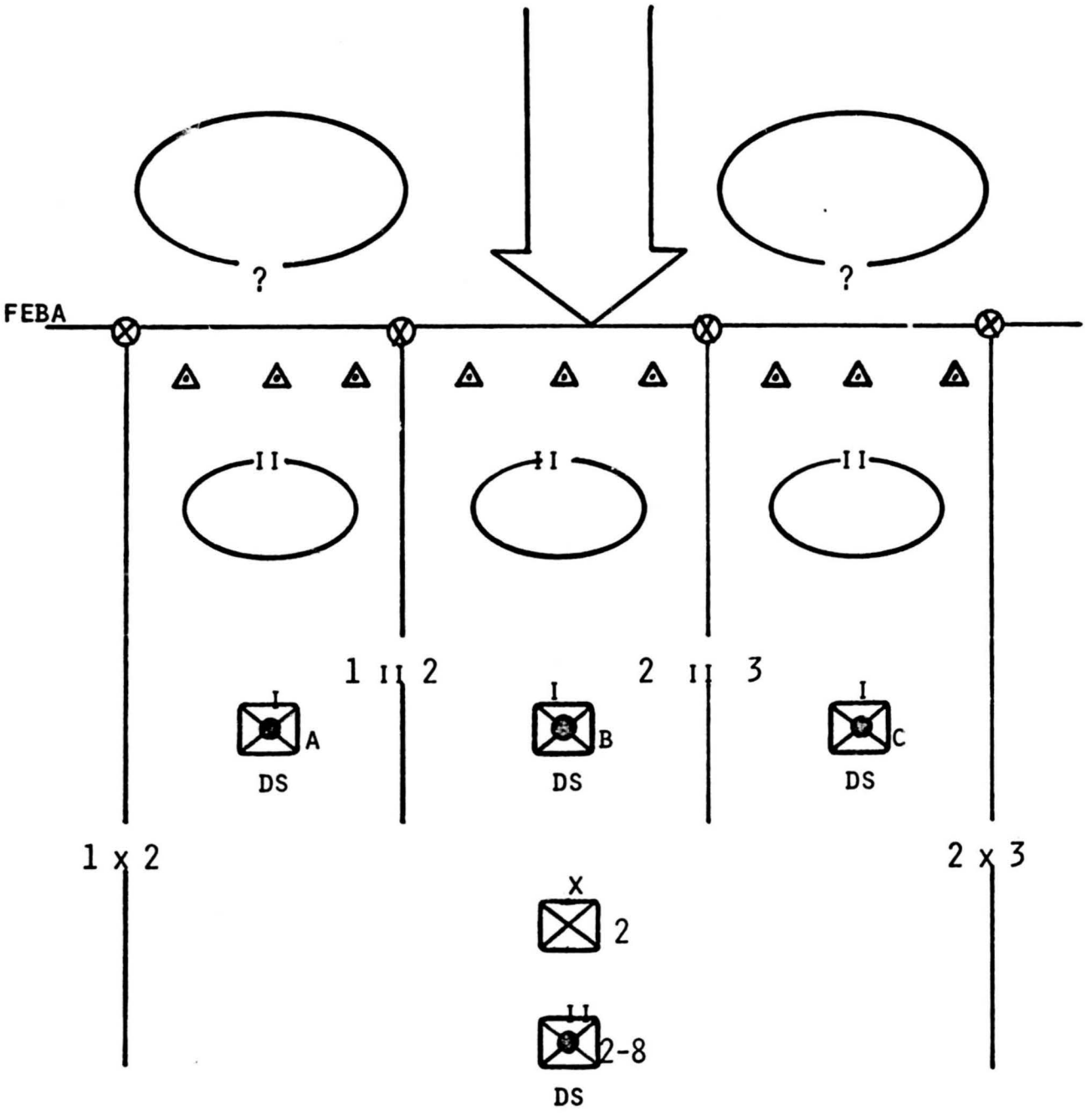


Figure 11. Scenario battlefield situation

The 155's are frequently considered the basic weapon in field artillery, and appear in several working combat models as the standard artillery piece. Each battery of 155's has six howitzers for a total of 18 tubes in direct support of the brigade.

The forces are shown in Figure 11 as they are positioned in this particular situation. As was discussed in the previous section, the brigade headquarters has a fire support coordination center, and the DS artillery battalion commander serves as the brigade FSCOORD. He remains in close contact with his own staff, and particularly the artillery battalion S-3 who is responsible for the battalion fire direction center. As before, this FDC is the central collection point for target lists from each firing battery; and receives the brigade fire support requirements, and apportions them to the three firing batteries.

The Red force is of undisclosed size, but it is known from intelligence sources that the Red artillery is tube type, and organized into batteries of six guns each. For convenience here it is assumed that the Red artillery has the same priorities in targeting, and fire support procedures as those discussed in the previous section.

There are two basic techniques for playing a combined arms combat scenario. The action can be moved through an iteration of battle by either a "time step" or an "event step" system. Here we will consider the sequencing of events, and no further discussion will be devoted to the actual

techniques of playing through the scenario. Rather, emphasis will be given to artillery decisions, and fire support planning.

In our discussion of decisions, it will be well to understand that even though artillery for this scenario is in direct support, and thus is highly responsive to the needs of the maneuver force, it maintains its own command structure, and maintains the authority to make all decisions of a technical nature. A close coordination with the supported maneuver force is required at all times.

At H-hour, the Red force initiates the battle with a 60-minute artillery preparation. As the first rounds begin to fall in the brigade sector, the artillery FSCOORD confers with the maneuver commander. Since the Blue force is in a posture of defense, extensive fire planning has been done. (See Figure 9.) All possible enemy assembly areas, opposing artillery positions, and likely avenues of approach have been adequately covered with fire.

After discussion with his FSCOORD, the brigade commander decides to fire the counterpreparation. This previously planned group of targets concentrates on counterbattery fire, and fire against known enemy observation posts. This early phase of the counterpreparation attempts to reduce the effect of Red artillery on both the maneuver force and gun positions. The Blue FO's actively search out enemy battery positions, and update the existing target information in a continuing process.

It is significant here that the important decision to fire the counterpreparation was made by the maneuver commander. However, the multitude of decisions as to target priorities, the number and type of rounds to fire on each target, etc. are made earlier by the fire planners. These artillerymen balance the needs of the tactical situation with the available ammunition and supporting weapons, and tailor the fire to the specific tactical situation. That is a strong argument for not using an arbitrary number like firepower scores, or a monte-carlo technique for determining fire planning decisions. When the requirement to fire a counterpreparation comes down to the artillery battalion, the information is sent to each battery FDC, and the prearranged fire is commenced.

As the Blue artillery brings effective fire on the Red forces, the preparation noticably decreases in intensity. As the Red preparation is shifted, their maneuver elements begin a frontal assault on the center of the brigade sector. As the assault forces close with the Blue unit, their forward observers pick up excellent targets of opportunity before they are required to displace rearward. During the initial stages of the attack the artillery battalion S-3 determines priorities and approves fire missions. The priority of fire at this phase goes to counterbattery fire to neutralize the Red indirect fire weapons, and targets of opportunity delivered to break up and stall the enemy attack formations.

As the assault successfully moves closer to the actual FEBA, the final protective fire, consisting of artillery and

mortars if fired. The decision to fire the FPF is made by the force commander at the critical time in the battle. The FPF effectively halts the Red assault, and now Blue artillery pours devastating fire on the enemy. As the FO's pick out targets of opportunity, the Red force suffers serious attrition.

Meanwhile at Blue force headquarters, plans are being finalized to initiate a counterattack. Since the enemy had been channeled by the effect of the Blue artillery, and stopped by the maneuver forces, we see how the combined arms battle depends on the coordination between maneuver and their artillery fire support. Once the Red attack stalls, Blue artillery fire is shifted to seal off the enemy position and prevent the reinforcing or resupplying of the committed force.

A separate fire support appendix had been previously prepared by the FSCC in support of the counterattack plan. Once again we see the overall decision to act made by the maneuver commander. But once again, the artillery FSCOORD and artillery planning channels have adequately analyzed the tactical situation and have made important decisions concerning the implementation of fire support.

Let us leave this scenario with the completion of a successful counterattack and a reoccupation of the Blue positions along the forward edge of the battle area (FEBA). Although it would be productive to continue the Blue attack and illustrate how offensive fire planning (Fig. 8) enters

this particular scenario, that is redundant to this discussion. Instead an effort to review the decisions made in the scenario to date is appropriate. The detailed walking through of both offensive and defensive phases of this scenario (as outlined here) would be highly enlightening, and is worthy of further thesis work to continue this investigation.

In the scenario just presented two important aspects of decision making are shown. As was stated in the introduction, the artillery has no mission, but to support the maneuver force. It therefore is logical, that the doctrine as presented earlier concerning the decisions of the maneuver commander is realistic. Note as the situation unfolds the decisions to fire a counterpreparation, to fire the FPF and to initiate the counterattack were all made by the maneuver commander. Granted, he is advised by his artillery FSCOORD, but the artilleryman can only advise. The artillery decisions then are concerned with those technical judgments concerned with the actual delivery of fire. These fires can be effective in supporting the maneuver element only if these decisions are made intelligently, and extensive fire planning is accomplished. It appears obvious in retrospect that the areas of fire planning and fire support coordination are extremely important consideration in any artillery model.

It is hoped that future work on artillery decision processes will extend to investigating specific considerations such as: available ammunition per tube, ammunition supply rate, and overall fire control procedures. The state

of the art in combat models needs much effort to realistically input artillery into a combined arms scenario. The use of field artillery on the modern battlefield cannot adequately be represented by simple firepower values for the capability against an opposing force. It has been shown how the overall maneuver force commander is an important decision maker, even in artillery considerations. The artillerymen are ultimately responsible for decisions concerned with the priority of targets, the amount of fire allotted for a particular target, and what type of fire support should best be used. Artillerymen are also responsible (although it has not been addressed here) for the positioning, resupply, communication nets, and movement of each individual artillery unit.

The use of field artillery techniques and the fire support decisions discussed in this thesis cannot help but assist analysts in modelling artillery for combined arms combat simulations. An understanding of field artillery operations is best acquired by those military officers responsible for, and experienced in, the conduct of fire support in actual combat. Unfortunately these people do not generally have the other analytic tools to devise a realistic artillery model. Interface between the professional soldiers and the professional analysts will add immeasurably to the overall analysis effort in the field of combat simulations.

APPENDIX A

GLOSSARY OF COMMON ARTILLERY TERMS

The following common terms in field artillery were taken from the text of references 16 and 17.

Airstrike--An attack on a specific objective by fighter, bomber, or attack aircraft on an offensive mission.

All available--A command or request to obtain the fire of all artillery able to deliver effective fire on a given target.

Area of operations (AO)--That area necessary for military operations, either offensive or defensive in nature.

Basic load--A specific amount of ammunition prescribed by the Army to be in the possession of each type organization.

Buffer Zone--That area immediately adjacent to friendly troops into which the armed helicopters will not fly.

Call for fire--A request for fire containing data necessary for obtaining the required fire on a target.

Conventional weapons--Nonnuclear weapons, excluding chemical rounds.

Counterbattery fire--Fire delivered for the purpose of destroying or neutralizing indirect fire weapons.

Counterpreparation--Intense prearranged fire delivered when the imminence of an enemy attack is discovered.

Covering fire--Fire used to protect assaulting troops when they are within range of enemy small arms.

Destruction fire--Fire delivered for the sole purpose of destroying material objects.

Final Protective fire (FPF)-- An immediately available prearranged barrier of fire designed to impede enemy movement across defensive lines.

Fire mission--A specific assignment given to a firing unit as part of a definite plan.

Fire plan--A tactical plan for using the weapons of a unit so that their fires will be coordinated.

Fire support coordination center (FSCC)--A single location at battalion and brigade levels in which are centralized communications facilities and personnel incident to the coordination of all forms of fire support.

Harassing fire--Fire delivered for purposes of disturbing the rest, curtailing the movement, and lowering the morale of enemy troops by the threat of casualties or losses in material.

Interdiction fire--Fire delivered for the purpose of denying the enemy the unrestricted use of an area or point.

Neutralization fire--Fire delivered to hamper and interrupt movement and/or the firing of weapons.

On-call target--A planned target to be fired on request rather than in accordance with a time schedule.

Planned target--A target on which fire is prearranged.

Preparation--Intense prearranged fire delivered in accordance with a time schedule in support of an attack, to disrupt the enemy's command and communication, disorganize his defenses, and neutralize his fire support means.

Protective fire--Fire delivered by supporting guns and directed against the enemy to hinder his fire or movement against friendly forces.

Scheduled target--A planned target on which fire is to be delivered in accordance with a time schedule.

Series of targets--A number of targets and/or groups of targets planned to support a maneuver phase.

Supporting fire--Fire delivered by supporting units to assist or protect a unit in combat.

Target--Personnel, material, or a piece of terrain that is designated and numbered for reference and/or firing.

Target of opportunity--A target which has not been planned.

Time on Target--The method of firing on a target in which various artillery units and naval gunfire ships so time their fires, that the first projectiles from all weapons reach the target simultaneously.

Zone of fire--An area within which a particular artillery unit is responsible for observation and delivery of fire.

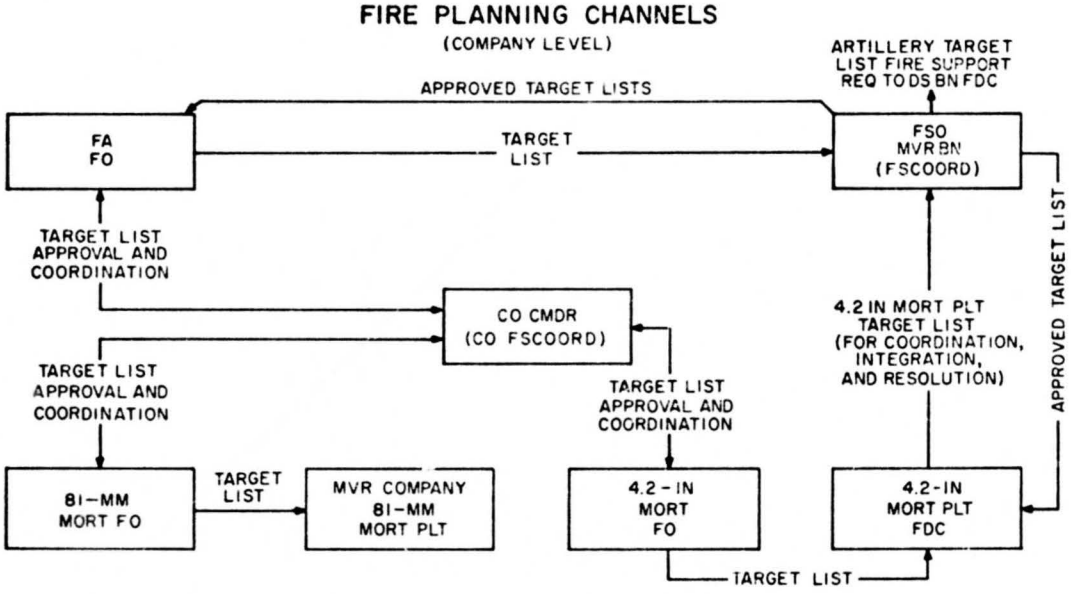
APPENDIX B

This appendix is provided to summarize the effective responsibilities each of the four standard tactical missions.

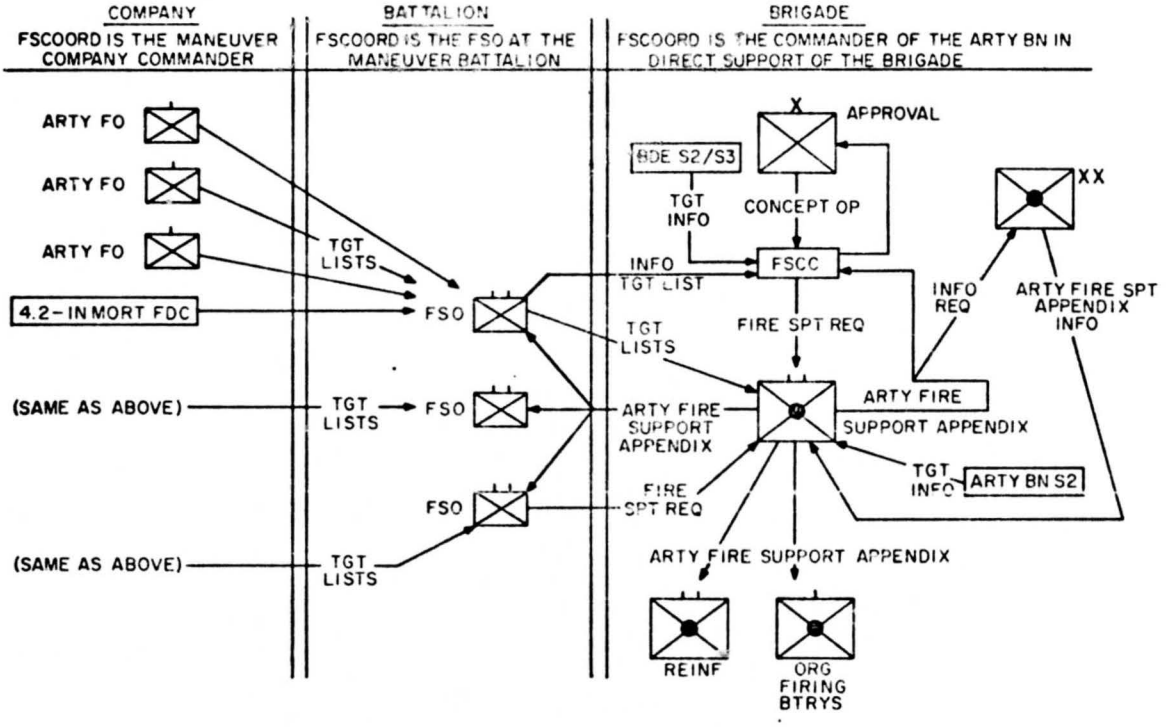
Artillery with a tactical mission of--	Answers calls for fire in priority from--	Establishes liaison with--	Establishes communication with--	Has as its zone of fire--
General support.	1. Force artillery headquarters. 2. Own observers.	No inherent requirement.	No inherent requirement.	Zone of supported unit/formation.
General support-reinforcing.	1. Force artillery headquarters. 2. Reinforced artillery unit. 3. Own observers.	Reinforced artillery unit.	Reinforced artillery unit.	Zone of supported unit/formation to include zone of reinforced artillery unit.
Reinforcing.	1. Reinforced artillery unit. 2. Own observers. 3. Force artillery headquarters.	Reinforced artillery unit.	Reinforced artillery unit.	Zone of fire of reinforced artillery unit.
Direct support.	1. Supported unit. 2. Own observers. 3. Force artillery headquarters.	Supported unit (down to battalion level).	Supported unit.	Zone of supported unit.

		Furnishes forward observers--	Is positioned by--	Has its fires planned by--
General support		No inherent requirement.	Force artillery headquarters.	Force artillery headquarters.
General supporting Reinforcing		Upon request of reinforced artillery unit, subject to prior approval of force artillery headquarters	Force artillery headquarters or, subject to prior approval, the reinforced artillery unit.	Force artillery headquarters.
Reinforcing		Upon request of reinforced artillery unit.	Reinforced artillery unit or ordered by force artillery headquarters.	Reinforced artillery unit.
Direct support		To (each*) company-size maneuver element of supported unit.	Unit commander, as deemed necessary, or ordered by force artillery headquarters.	Develops own fire plan.

APPENDIX C


FIRE PLANNING CHANNELS
(COMPANY LEVEL)
ARTILLERY TARGET LIST FIRE SUPPORT REQ TO DS BN FDC
APPROVED TARGET LISTS
FA FO
TARGET LIST
FSO MVR BN (FSCOORD)
TARGET LIST APPROVAL AND COORDINATION
CO CMDR (CO FSCOORD)
4.2 IN MORT PLT TARGET LIST (FOR COORDINATION, INTEGRATION, AND RESOLUTION)
APPROVED TARGET LIST
TARGET LIST APPROVAL AND COORDINATION
TARGET LIST APPROVAL AND COORDINATION
81-MM MORT FO
TARGET LIST
MVR COMPANY 81-MM MORT PLT
4.2-IN MORT FO
4.2-IN MORT PLT FDC
TARGET LIST

FIRE PLANNING CHANNELS
(BRIGADE LEVEL)



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